

# Pre-Service Elementary Teachers' Experience in a Community of Practice through a Place-Based Inquiry

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With this case study, we explored efforts to connect pre-service elementary teachers (PSTs) and campus scientists through place-based inquiry instruction. Using the framework of Community of Practice (CoP), the research question guiding this study was: what features of our place-based inquiry course intervention (involving PSTs and scientists) afforded or constrained the extent to which our students moved toward a fuller involvement in the CoP? The results indicated the PSTs were able to participate in a CoP engaged in authentic scientific inquiry and were able to move through levels of legitimate peripheral participation in varying degrees while maintaining their identities as future elementary teachers. Additionally, place-based inquiry was an effective means of including PSTs in the CoP by enabling them to provide a unique knowledge set to partnering scientists and to build arguments based on authentic local inquiry.

**Keywords:** community of practice, socio-scientific issues, pre-service teachers, college teaching

## Background

In this study, we aimed to extend the potential of place-based education for our elementary teacher education program by creating an experience for our pre-service teachers (PST) in which the ideals of a Community of Practice (CoP) may be realized. Employing place-based inquiry, this course intervention centered on extending the learning context beyond the walls of classroom into the local campus community of practicing scientists. By using the framework of legitimate peripheral participation (Lave & Wenger, 1991), which asserts that learning is a social process whereby knowledge is constructed between learners and experts, situated in a relevant context, and embedded within a particular social and physical environment, we sought to engage the PSTs in discourse with scientists about campus environmental issues and provide the opportunity to legitimately participate in a CoP that focused on place-based inquiry.

### Engaging PSTs in a CoP with Scientists

Research calling for an educational approach that views science learning as a community practice and the learners as active participants in community-based dialogues (Kolstø et al., 2006; Hodson, 2003) focuses on developing learners that contribute to community action in collaboration with peers, educators, and community members. Thus, it is argued that science education should allow students to participate in legitimate ways in community life (Dos Santos, 2008). Thus, the call for science education to be a pathway for active student participation in science is leading the way for valuing more voices and backgrounds in the field of science, as well as providing opportunities for students to become involved in decision-making about scientific issues that impact their community. As a case is being made for politicizing students through issues-based curriculum to assess the value of and critically evaluate knowledge in a particular context and to participate in the social negotiations that produce knowledge, the challenges for pre-service teacher education to engage learners in these types of experiences are paramount.

Responding to calls for democratizing participation in science, Claudia Melear (1999) argued that current pre-service methods preparation does not adequately enable PSTs to experience authentic participation in real science and thus inhibits them from being able to provide these experiences for their future students. She recommended that training for PSTs should mimic the part of a scientist's training of 'hanging around with' scientists who have varying degrees of expertise, in order for them to be properly acculturated into the science they will be expected to teach. In her case study, PSTs worked in laboratories as part of their teacher training. Her results indicated numerous ways science teachers benefited from working with scientists in their laboratories (i.e. learning lab techniques, experiencing real data and authentic analysis, conducting open inquiries, etc...) before leaving their pre-service teacher preparation programs. Melear argued that science educators should work collaboratively and diligently with scientists to provide these kinds of opportunities for pre-service science teachers and moreover, they should be built into the curriculum.

Echoing the value of research apprenticeships, Sadler, Burgin, McKinney, and Ponjuan, (2009) reviewed a collection of research on the effects of apprenticeships for high school students, undergraduates, pre-service, and in-service teachers. The authors showcased how research apprenticeships enhanced interest in or aspirations toward scientific careers and understanding of aspects of the nature of science. They also noted that the absence of outcomes was typically associated with shorter duration apprenticeships (i.e., 2-week experiences) and go on to make three recommendations based on their findings. First, research experiences should be extended over time. Second, these experiences should be supplemented with activities specifically designed to draw apprentices' attention to desired learning outcomes. Finally, apprentices should be engaged in the higher-order practices of research, including analysis of data, generation of hypotheses, and development of research questions.

Although not with scientists, Akerson et al., (2012) investigated the ways in which a Co, consisting of university faculty and pre-service teachers, assisted in the development of pre-service elementary teachers' nature of science instruction. They determined that the participation in a CoP inspired all PSTs to explicitly teach the nature of science (as was recommended) in their student teaching despite the fact that their cooperating teachers did not teach it, though they did so at varying degrees. Participation in a CoP was imperative for the development of their instruction, and as the researchers asserted "provided a venue for these particular pre-service teachers to share ideas and gain support for NOS teaching despite being in a classroom where classroom teachers did not know or teach NOS (p. 1390)." Akerson et al. go on to recommend that pre-service education should incorporate CoP into program efforts and that students should be separated into small groups to work more closely in smaller CoPs, which has been shown to be effective with in-service educators as well (Akerson, Cullen, & Hanson, 2009). Though our efforts centered on involving PSTs in a CoP of practicing scientists rather than with education faculty, this study provided an example of the importance of involvement in CoPs for pre-service training.

### Connecting PSTs to Place through Inquiry

By contextualizing instruction in real world issues, place-based inquiry can often be meaningful to students and to the local community. The focus brought forth by the National Academy of Sciences (2012) has underscored the importance of students collecting data, analyzing claims and evidence, and understanding multiple perspectives—all of which are of central ideas in the *Next Generation Science Standards* (2013). Though too often in current curriculum, important scientific issues such as global warming (including deforestation) and water quality of a hypothetical city or rainforest conservation are not addressed in ways that connect to students' daily experiences. Situating instruction in a local context, we aimed to offer PSTs an opportunity to become active participants in their community through the study of environmental science that affects their own campus community and thus their lives. Involving place was important to our efforts because of the relevancy and opportunity for impact it could confer within the study of complex local environmental issues.

One approach to situating instruction in a place-based context is through participation in local environmental action. Situating instruction in a local context, Roth and Lee's (2004) 3-year ethnography on science as a "community of practice" in which students collected data on a local creek showed that situated, authentic learning allowed students to participate in legitimate ways in life while providing valuable assistance to their community. This authentic practice, researchers assert, can move classrooms away from mock de-contextualized laboratory to engaging students as valuable citizens in place-based action. Roth and Lee view students as active producers and creators of scientific knowledge that contributes to community action in collaboration with peers, educators, and community members. Students can engage in multiple aspects of the research process, including defining research questions, collecting and analyzing data, interpreting results, and communicating conclusions. As part of a project of rethinking scientific literacy, this multisite ethnographic research project in which they investigated science in the community provided descriptions of science in a local middle school, where students learn science while participating in a community effort to contribute to the knowledge base about a local creek. Thus, this science education allowed students to participate in legitimate ways in the science of community life.

One of the most compelling reasons to adopt place-based education is to provide students with the knowledge and experiences needed to actively participate in the democratic process (Tan, 2009; Flessner, 2009; Pelo, 2009). Grappling with local environmental issues can hone understandings of environmental science and the systemic societal influences and constraints, skills in scientific inquiry, and civic engagement—elements which are crucial to participation in a democratic society, community building, and critical analysis (Battistoni, 2002).

In our study, we sought to contextualize the above recommendations in our science course for future elementary teachers through active participation in place-based inquiry. Rather than employing an apprenticeship model, we aimed for our students to engage in a CoP with campus scientists through their learning about complex environmental issues that intersected their interests and allowed them the opportunity to contribute meaningful data to inspire change on campus.

Fostering participatory working groups of students and scientists throughout the course of a semester, we aimed to offer PSTs an opportunity to become active and valued participants in a scientific community and to position them as legitimate, competent partners in the community's discussions involving environmental science. In light of this, we did not seek to place our students in the scientists' labs, but instead attempted to facilitate dialogic partnerships in which the PSTs and scientists addressed local concerns. Our hope was that learning through place-based inquiry instruction involving campus issues and opportunities to intersect with a community of practicing scientists would enable and inspire these future elementary teachers to more fully connect with science as a community practice. Specifically, the question guiding this study was: What features of our place-based inquiry course intervention (involving PSTs and scientists)

afforded or constrained the extent to which our students moved toward a fuller involvement in the CoP?

### **Framing**

To operationalize our goal, we turned to the work of Lave and Wenger (1991) regarding CoPs. Our PSTs had experienced traditional learning of science in high school, but had not before participated alongside scientists in investigating socio-scientific matters of local concern. They were complete outsiders to the CoP of practicing scientists; though we were aiming for them to experience social participation in a community of practice through their study of place-based inquiry that was relevant to their lives as students on campus. According to Etienne Wenger (1998; 2007), three elements are crucial in distinguishing a community of practice from other groups and communities: 1) *The domain*: In earlier work referred to as ‘joint enterprise,’ the domain has an identity defined by a shared domain of interest. Membership therefore implies a commitment to the domain, and therefore a shared competence that distinguishes members from other people. Here, as PSTs learned about campus environmental issues and how they intersected with the varied interests of students, they would develop an expertise that enabled them to understand and contribute to the shared domain of interest in the CoP; 2) *The community*. In pursuing their interest in their domain, members engage in joint activities and discussions, help each other, and share information. Also referred to as “mutual engagement,” the community aspect of the CoP is building relationships that enable participants to learn from each other. Here, the PSTs would come to develop relationships of mutual learning and contribution with the scientists in the CoP; and 3) *The practice*. Members of a community of practice are practitioners. They develop a ‘shared repertoire’ of resources: experiences, stories, tools, ways of addressing recurring problems—in short a shared practice, which takes time and sustained interaction. In our study, PSTs had to conduct inquiries alongside scientists in which they collected and analyzed data from the campus community to contribute to the scientists’ campus environmental management plans. Therefore, we believed that by integrating our PSTs into a CoP we could not only realize the teacher preparation science standards and aims for scientific literacy, but also position place-based inquiry as a means by which our PSTs could experience scientific inquiry in their community.

### **Description of Methods**

Our inquiry was rooted in our ultimate goal to foster students’ understanding of and participation in community-based science dialogues. We chose to re-conceptualize one of the required science courses in our teacher education program in order to attain this goal. The context, participants, and course intervention are described below.

### **Context & Participants**

Twenty-four sophomore undergraduate PSTs enrolled (15 females, 9 males; 2 African-American, 2 Hispanic or Latino, 20 White) in a Mid-western university class were asked to participate in this semester-long study. The science class was comprised of PSTs who expressed an interest in becoming elementary school teachers, but had not yet officially entered the teacher education program (for which acceptance occurs during the junior year). The overarching goal of the science content course was to engage students in authentic inquiry with regard to science concepts prior to learning inquiry-based pedagogy in a subsequent methods course so as to provide them a basis for reflection. As such, activities throughout the semester centered on inquiry, the nature of science, data analysis and interpretation, and connecting learners with both the on-and off-campus scientific community with regard to local campus environmental science issues.

The six participating scientists (3 female, 3 male; ranging in age from 31-60 years) were selected because of their affiliation with the Office of Sustainability’s project initiatives (i.e.

transportation, water quality, energy usage, availability of healthy food options, greening computer usage, the adoption of e-books, campus community gardens, etc...). The scientists, who possessed Masters Degrees in science (see Table 1), were hired by the University to direct teams of affiliates to work on the project initiatives ranging from community partners to interested students. Their ultimate goal for each year was to develop a Master Plan for enhancing the environmental sustainability initiatives underway on campus. Some projects were new initiatives, while others had been underway since the inception of the Office of Sustainability two years prior.

### **Intervention**

In our course intervention, the issues of focus for the CoP (campus environmental management) necessarily involved consideration of the perspectives of the PSTs. Designing campus management plans required consideration of multiple political, economic, and social ideas as well as scientific understanding of the ecological needs of and impacts on the community. This provided an opportunity for students to learn science while assisting the many faculty and university personnel working on the management plans with authentic data collection and analysis.

Rather than creating a project around a contrived or “fake” issue, we wanted students to legitimately participate in and ultimately have the potential to affect a real campus problem. For example, the campus management plan concerning the reduction of waste generated at athletic events required that students who use the facilities and tailgating areas be aware of and educated about the proposals to increase recycling efforts and introduce composting alternatives to waste disposal. The scientists’ work on this issue required that students be involved in the effort if it was to be a success. In the same vein, the campus’ energy reduction attempts at dormitories necessitated that students actively participate in conserving water and reducing energy needs in their living spaces. Thus, the students were directly connected with the success of the CoP’s efforts.

The scientists attended one or two of our class sessions to brainstorm project ideas with the students as well as communicated with the PSTs throughout the semester. They also attended the final poster presentations during which PSTs showcased the results of their inquiry projects with the potential of incorporating their work into the campus environmental management plans. Some scientists set up data collection sites and assisted PSTs with the actual field-based data collection (i.e. e-waste group and greening athletics group), while others assisted PSTs with the initial plans for data collection, but did not assist the data collection in the field (i.e. community gardens group, energy group, and nutrition group).

The opportunity for legitimate peripheral participation was realized through the use of semester long place-based inquiry intervention in which the PSTs investigated on-campus environmental issues (i.e. transportation, water quality, energy usage, availability of healthy food options, greening computer usage, the adoption of e-books, etc...). In their investigations, they paired with campus scientists involved in working with these issues to share data, discuss potential solutions, and collaboratively reflected upon the implications of their studies. The project outcome for the PSTs was to present their findings and recommendations to the scientists in a poster symposium and written paper at the completion of the semester.

Groups of four PSTs chose a topic within the over-arching category of ‘Campus Environmental Issues.’ We narrowed the choices of which environmental issues to explore based upon the new and continuing projects being conducted by the Office of Sustainability at our University. Then, based upon the PSTs’ personal interests and available options, they chose the projects on which they would conduct their inquiries. Inquiry topics included energy use on campus, nutritional awareness and options for healthy eating, e-waste, and community gardening. All projects consisted of an exploration of the scientific content and socio-political aspects of the environmental issues. Ultimately, the groups designed a campus inquiry during which they would pair with scientists who specialized in that research area. Scientists helped guide the PSTs’

inquiry designs (by attending class to guide the brainstorming process and communicating via email throughout the data collection and analysis) to align with data in which they may have been interested (see Appendix A for a complete description of each project).

Essentially, the PSTs were required to first research the scientific background in their topic using primary literature, then after pairing with scientists they generated an inquiry topic on which they could collect data over the course of the semester. Next, the PSTs had to analyze and interpret their data to ultimately showcase their recommendations at a final poster symposium. They also were required to design a means by which they could inspire others to learn about their project through some type of educational outreach component. Additionally, during the inquiry design process, the students discussed their inquiries with members of the scientific community at a local event called Green Drinks.

Green Drinks is a monthly public meeting to showcase sustainability-related events and opportunities in the community, as well as a chance for those interested in environmental issues to mingle and network. Typical attendees include on and off campus scientists, business owners, and environmentally conscious citizens. Each event has a host speaker who discusses important sustainability initiatives in the community. The goal of this event was for PSTs to discuss their project ideas with a wider audience to inform the direction of their projects as well as make connections regarding their interests. Partnering scientists also attended this event, which allowed for another opportunity to connect them to PSTs.

### **Data Collection & Analysis Techniques**

This was a case study with influences of phenomenological theory. The phenomenological orientation indicates our focus on the participants' firsthand experience of the phenomenon (Merriam, 1998). Our data sources were reflective of ongoing reflection and communication needed to systematically explore students' perspectives. These sources included our own researcher journals, reflective journals of the PSTs, audio-taped classroom and community interactions with PSTs and scientists, interviews with PSTs and scientists, and inquiry project artifacts such as student collected data and final poster presentations.

The data collection occurred during a semester-long period during the fall of 2010. Classes were held twice a week for 2 hours each. Collaboration with the scientific community was held during class time and at the discretion of the partnerships outside of class via email and/or informal meetings. PSTs maintained ongoing journals throughout the semester to reflect on their experience of legitimate peripheral participation, and each PST and scientist participated in an individual interview (15-20 minutes) (see Appendix A and B respectively) immediately after their collaboration during one or two classroom sessions (2 hours each) during the semester. We also documented not only our reactions, thoughts, and feelings over the course of the semester in a daily journal, but also daily course happenings. This helped us to reflect on our teaching and confront our own assumptions about the collaboration between students and the scientific community. Materials such as student work, teaching activities, and informational supplements were collected from participants, copied, and submitted to Author 1 (who knew which students were participating). All documents were part of the requirements of the course.

In the analysis of our data, we used Wenger's (1998) concepts of a CoP as consisting of three interrelated terms: 'mutual engagement', 'joint enterprise' and 'shared repertoire' (Wenger 1998, pp. 72-73) as a guide for coding ideas and events that the participants referenced. Specifically, we first looked for instances whereby students were involved in a CoP as described by Wenger. We then reviewed the data a second time, mining data for instances that countered the involvement in a CoP. This enabled us to glean the factors that PSTs referenced as affordances or constraints to their participation in a CoP with the scientists. When referenced, secondary data sources (classroom artifacts and instructor journals) were used to triangulate data interpretation. The data analysis for changing PST identity consisted of an iterative and inductive process of analysis in order to formulate qualitative accounts. Through a careful analysis of the data, trends and discrepancies were found and categories emerged. This resulted in the formulation of a few

exemplar accounts that underscored the analytic angles of the study, namely, the ways in which features of the place-based inquiry (involving PSTs and scientists) afforded or constrained the extent to which the PSTs moved toward a fuller expression of involvement in the CoP and the ways in which this experience mediated PSTs' identity formation as science teachers. Qualitative data gathered through this research and reported here were analyzed using the constant comparative methodology until researcher consensus was attained.

### **Validity Techniques**

Methodological triangulation was used to support validity of the data collected (Stake, 1995). The data were collected through observations, document analysis, and reflective accounts from PSTs, scientists, and instructors as ways to increase the confidence of the interpretation. Agreement among data (convergence) as well as inconsistencies and contradictions (divergence) were found as a way to uncover new issues and interpretations. We observed each class and related activity over the course of the semester, which constitutes prolonged engagement. Both field notes and the thick record of each observation were transcribed using low-inference vocabulary to try to eliminate potential biases regarding what occurred in the setting. Because some biases may have arose despite these attempts, we also used peer de-briefers to check all of our thick records for interpretive accuracy until complete consensus was achieved. In addition, we also employed the use of negative case analysis, in which we noted instances that contrasted the reconstructed themes once they had emerged and explore explanations for the lack of fit. This occurred with one student, Clara, who contrasted many of our interpretations of other students. Exploring her case prompted a review of all other cases, which assisted us in ensuring we did not overlook other potentially contrasting cases. The interviews with participants utilized non-leading interview techniques throughout the interview process, and we asked peer de-briefers to help check for biases in our interview questions and techniques.

A caveat to this study, as well as most qualitative studies, is that it focused on detailed interactions among a small number of participants. Thus, in qualitative inquiry, generalizability is not a function of sampling. Because individual experience is the unit of analysis, researchers are interested in selecting cases that provide a lot of detailed information about the topic of interest, rather than a representative group that will aim to provide insight to multiple populations. Judgments about transferability are based on information regarding the investigator, the setting, the methodology, the participants, and the nature of the relationships between the participant and the researchers.

### **Findings**

Below, we present both our students' and the collaborating scientists' view of their experience working together by examining the on-going reflections by the PSTs, as well as the interviews with the scientists. Within these perspectives, descriptions of what the participants considered to be the most valuable aspects of their partnerships are presented, showcasing the essential features of the curriculum that allowed for the PSTs' movement into this CoP. Additionally, we will elucidate the features of the place-based inquiry which constrained the extent to which the PSTs moved toward a fuller expression of involvement in the CoP and the ways in which engagement in this experience mediated PSTs' identity formation as elementary teachers of science.

### **Inclusion in a Community of Practice**

There were several factors noted by the PSTs that helped to support their movement into the CoP. Results below are presented using Wenger's notions of mutual engagement (participation in the community), joint enterprise (collective understanding of what binds them together), and shared repertoire (access to communal resources with both literal and symbolic meanings).

**Mutual Engagement.** Overwhelmingly, PSTs referenced the experience of actually dialoguing with the community about their projects, rather than merely discussing them in class with other groups, as the most essential component of their experience of moving into a community of practice. They considered the most important of these dialogues to be their experience with scientists at Green Drinks. The PSTs' attendance at this event was a chance for them to dialogue with scientists and community members about their burgeoning projects. At Green Drinks, the PSTs were able to gather more information about the project on which they were embarking. As Rene claimed about her experience, "*Asking questions to the others who were presenting and getting asked questions made me want to look deeper into our inquiry and think about where I am going with it.*" Because their attendance at Green Drinks was done after their initial research into the primary literature on their chosen topic, but prior to their inquiry development, they were able to think deeply into what the community valued as important study of the campus environment while integrating their research-based and personal understanding of the issue.

Not only did participating in Green Drinks and talking to the campus community broaden student perspectives on environmental issues, many PSTs reported being able to offer points of consideration to engage in discussion with attendees- an indication of their initial movement into the CoP. In Keesha's conversation below, she poses questions to probe deeper about the campus' greening athletics efforts:

*I then brought up [to the scientist] the point that with no financial ties to their energy consuming procedures used, the athletic department really has no incentive to change. However, he counteracted that statement mentioning that the athletic department is working very diligently to make changes and keep up with other schools in the Big Ten Conference, but the changes are just ever-so-slight and will require time and patience. When you get surrounded by people who all share the same passion to make changes, it not only makes you more motivated, but also puts into perspective the importance of the situation.*

Keesha expressed that she learned more about what her campus was doing with regard to greening the athletics department during her conversation, but also felt comfortable asking questions about the campus' incentives for change.

In fact, all PSTs journaled about the positive reciprocal nature of the dialogues at Green Drinks. Clara felt the conversations were also mutually beneficial and was excited about having the opportunity to learn more about her topic from people who actually worked with environmental issues:

*We got a lot of good conversation in and I think both of us learned something from the other (though I likely learned a lot more!). Being able to put the idea past someone with a lot of experience in the field was a great opportunity for me, and hearing her feedback on it was really helpful and heartening.*

Here, Clara expresses her enthusiasm for the feedback she received about her burgeoning inquiry on community gardens. She noted the exchange to be of benefit to both the scientist and herself despite her student status, and seemed to feel that her voice was valued by the community. Not only were the PSTs learning from the attendees about what science was valued in the campus community, but as Clara expressed, they were contributing as well.

Another PST, Amelia noted a similar sentiment of inclusion when she said,

*"A strength to a meeting like this is the informality of the environment, everyone is more than welcome to share their opinions, thoughts, or ideas, and are ac-*



*usually encouraged to share. This takes away any feelings of rejection or a sense of being unwelcome.”*

The PSTs were armed with some basic knowledge of the issue from their initial research and were able to confidently engage in dialogue with the community who were able to guide them not only to think deeper into their environmental issues, but also to feel welcome to share their own ideas.

The experience at Green Drinks allowed PSTs to gain a sense of community inclusion within their science learning. Below, Mary’s narrative of her experience at Green Drinks suggests that not only did she gather insights for her inquiry project, but she also felt surprised about how comfortable, even empowered, she felt talking to community members about her project:

*Going into the night at Green Drinks I was not sure what to expect. In our mind, I imagined a lot of older people, nicely dressed, were going to walk around and simply listen to what we had to say about our projects. Occasionally, they would add a nod of understanding. But after listening I figured they would just move on to the next group and conduct the conversation in much the same manner. Boy was I wrong. First of all, the people at Green Drinks were not all older. Yes there were middle-aged folks, but there also were a good amount of younger adults, perhaps a few years out of college. Secondly, these people were not dressed overly fancy, and did not create an air of “I am wiser than thou” which I half-expected. The adults were casually dressed and had very open personalities.*

Mary’s preconceptions about what it meant to engage in dialogue with scientists were challenged by the attendees’ physical appearance (i.e. young and casually dressed) and their eagerness to hear what she had to say. It was also important to note here that Mary was not only taking in the recommendations and suggestions from those with whom she spoke, but she was also making decisions about what was valuable information for her project-- an indication that she was part of the community of practice deciding what was the most pertinent information to draw forth into her project.

**Joint Enterprise.** PSTs also claimed that working closely with the campus scientists to design their inquiries was an important aspect for their movement into a fuller expression of this CoP. They frequently noted that there was mutual benefit in this student-scientists partnership in terms of meeting their course goals as well as contributing data that would be useful to real scientists. In a class discussion, Leona added:

*I feel that collaboration is such a big part of the success of science, and our group’s success is no different. There is no way only one of us could have done all of this research and planning. It was of vital importance that we all work together to come to an agreement and share our information and data on the project.*

The experience of conducting their science learning outside of the classroom in an effort to impact and understand campus environmental issues necessitated collaboration with those involved in the issues.

The PSTs also noted in their reflections on their student-scientist partnerships the importance of the scientists’ involvement in terms of permitting them to conduct inquiries they felt were meaningful to the campus community. Hadley described how her partnership with the campus food dietician was key to her group’s ability to study and contribute knowledge to campus nutrition issues that were considered important to the dietician;

*"She pulled a lot of strings for us so that we could collect data from a reputable chain restaurant. We couldn't have collected the data that we were able to, or even finish for that matter if it were not for the active participation that we received."*

Hadley felt that the dietician was eager to help her group because she had an interest in their findings- an indication that the partnership was mutually beneficial.

Having access to expert knowledge and obtaining permissions to conduct their various inquiries required the PSTs to be in contact with the collaborating scientists throughout the semester. Therefore, the scientists were aware of the projects and made available many opportunities to contribute meaningful data and recommendations that had the potential to be utilized by the scientists. For example, after conducting their food audits at the athletic dining halls, the PSTs were able to contribute the data they had analyzed and make recommendations to the Office of Sustainability (which was closely working with the athletic departments to help facilitate more 'green' practices) that had an immediate impact on campus. Based on their data, the PSTs recommended the use of a composting system and were able to inform others about the amount of food waste that would be re-directed into a potential alternative waste system, data the scientist was then able to use to further efforts for funding for a composting system. This close work alongside campus scientists throughout their conception, design, and implementation of their inquiry allowed PSTs to be included in a CoP in which they had the potential of impacting real change on campus.

**Shared Repertoire.** In their post-collaboration interviews, the scientists noted several reasons for the value of this partnership. First, working with students who were developing into teachers was important as the scientists saw teachers as an essential component for translating the importance of environmental issues to their future students:

*Campaigns to combat environmental issues must be rooted in education. The issues that we face today require the input of many different professionals in order to be solved. To reach this diverse population you must first reach teachers. Teachers can help environmentalists by turning broad issues into tangible classroom exploration. I enjoyed making our work academically relevant.*

Making their work 'academically relevant' meant including pre-service educators as an important piece of the solution to some of the campus environmental issues. After all, behavior changes such as lessening one's energy consumption begin with awareness; and the scientists understood that future teachers could create awareness by teaching their students about these important issues. Thus, the scientists valued educators' role in these conversations. Second, scientists also noted that the PSTs were able to contribute unique knowledge that aided their projects:

*Their perspective was valuable since they worked from a topic they not only got a grade for working on, but one which they felt a need to address! The input and voice of the students is really important since they represent the actual customers we serve at RPS Dining, and can express what their friends and classmates feel about issues.*

Here, scientists recognized students' personal motivation with the topic and asserted that the PSTs contributed unique knowledge about the student perspective. The willingness of the scientists to allow the PSTs entry into the CoP was paramount to the success of this experience.

Post-collaborative reflections from the scientists also indicated that the PSTs' involvement in the campus environmental inquiries contributed data that the scientists wished to showcase. Erin, the Assistant Director of Office of Sustainability, asked that the PSTs share their

work at the OOS symposium at the end of the semester, which highlighted her view that their work was worthy of being noted by the larger scientific community who would be in attendance. As well, the campus dietician asked if the PSTs would like to post the results of their inquiry on the effects of posting nutritional content of popular items on food choices. She offered her own campus blog as a venue for them to showcase their findings by creating table tents for the dining hall:

*“I suggested an effective way to communicate findings to students (flatscreen TVs in dining halls which stream headlines about RPS topics) so I’ll submit the info to marketing if that’s what their group decides on.”*

She saw the PSTs’ study as a worthy contribution to the nutrition awareness campaign on campus and valued their work by making it possible for others to learn about their study. These data allow us to see the ways in which PSTs movement from the periphery of the CoP into a fuller expression of inclusion depended not only on their own evolving interests and engagement, but quite heavily on the scientists willingness to allow them to take part.

### **Exclusion from the Community of Practice**

While most of the PSTs were aware that they lacked the expertise in science that was clearly held by the scientists with whom they worked, they were able to still feel as though they had unique knowledge to contribute. Others, however, were not able to move past the sentiment that their work was less valuable and/or inferior to the ‘real’ science that the scientists were doing. For example, Clara chose to join the group investigating community gardens and the benefits they brought to the nutrition on campus by offering organic food as well as the opportunity to learn about the needs of plants, soil properties, and ecological systems. When meeting with the community garden scientist from the Office of Sustainability to discuss relevant research questions that would allow the PSTs to design inquiries about the science behind the topic as well as aid in the creation of these plots on campus (an initiative approved by our campus architect only one month prior), Clara was dismayed at what the scientist suggested they research:

*What are we trying to discover? What’s our theory? Can we even prove it? I just feel like we sort of got the short end of the stick when it came to who-does-what-part. I wasn’t expecting to essentially do the gruntwork. I was hoping to get in the field and experience the community gardens here in town, to see which sorts of plants do well where, to test soil quality in different parts of campus, to really get INTO the community garden aspect.*

Because this was a new campus project in its infancy, and the collaborating scientist had specific data she wanted collected by the PSTs and saw this partnership as a means by which those data could be collected (i.e. demand of produce on campus, differences in organic vs. non-organic food). However, Clara felt her inquiry was overly directed by the scientist and that her interpretation of the data nor resulting recommendations did not matter. Clara’s feeling that she was ‘essentially doing the gruntwork’ for the collaborating scientist was instrumental in her feelings of non-inclusion into the CoP. In Clara’s example, the group experienced a constraint on their ideas about the inquiry they wished to conduct and their data was simply turned over to the scientist without much in the way of interpretations or recommendations. PSTs in her group left feeling as though their data collections did not adequately foster the sense of scientific inquiry they could see the other groups experiencing.

From the perspective of the scientists, another constraint on the involvement of the PSTs in a CoP was the fear that this inclusion would “inject another level of complexity and take away from our limited staff time and interfere with the [scientists’] research” (Director of the Office of Sustainability, Interview). This partnership was not a common occurrence in the program and

was one that required a great deal of pre-planning and deep thought about its potential merit. Ultimately, however, the scientists agreed to engage with the PSTs not only because they saw the merit of involving students who would ultimately be teaching future generations about sustainability, but also because they wished to incorporate student data into their generation of potential solutions for the varying campus environmental issues.

Even during the collaboration, boundaries had to be set in terms of the PSTs' inquiry projects not overstepping the scientists' project efforts. In designing their research questions, the PSTs wanted to conduct an extension to the 'Energy Challenge,' a competition among residence halls to lessen the energy usage on campus; however, the scientist was concerned about exposing confusing messages to the residents and offered an alternative idea for a classroom inquiry project:

*"I fear that such a project will not be easily understood by the residents. Another possibility would be to conduct interviews or take surveys in the lowest scoring buildings to gauge the level awareness."*

Because the scientists possessed far more training than the PSTs on their environmental issue and had far more at stake than a class project, the concerns about taking on another level of complexity to their projects understandably caused them to take heed.

As well as being mindful about setting clear boundaries, the scientists were also concerned at the commencement of the collaboration about the novel way in which the PSTs were seeking to contribute data to their projects. One of the collaborating scientists echoed Mr. Alexander's concern about creating unnecessary complexity for the scientist and their work when she was asked in an interview about her initial impressions of the collaborative work:

*Members within the scientific community tend to stay there when they have an issue to pursue. In the eyes on many, it is easier to stay within what you know than reach out to another group – even if that group has valuable insights. I think some members of the scientific community feel that translating an issue such that it is relevant to another group is not an efficient use of time.*

The scientist was concerned that working with the PSTs meant having to explain technical jargon and proper procedures for valid data collection, distracting from her time and important work. Her claim was that scientists tend to be an insular community and that they possess unique knowledge that is not often accessible to others outside of their group. In the tacit claims here, references to a hierarchy of knowledge and skill level emerged as an important pattern of the scientists' perspective in the pre-collaboration data. Although often subtle and nuanced, concerns about upsetting structure and hierarchies surfaced repeatedly throughout the partnership.

### **Changing Identities**

When exploring the changing identities of the PSTs throughout the course, it was notable that PSTs continually referenced their work as scientists. Brian worked with the campus dietician and alluded to the important access of this collaboration in making his work on nutrition seem more like experiencing meaningful science learning:

*I was doing many of the things that I thought scientists had to deal with such as setting up data collection and discussing with experts in the field. As for the data collection, it seemed very scientific. Our group had to think through all of the possible ways to collect the data and decide which one would be most effective. As for meeting with professionals in the field, this was when I felt that the science was most legitimate. Raphael has studied nutrition for most of her life and collaborating with her on a project was really cool. She didn't control it though.*

Here, Brian illustrates that his experiences were ‘legitimate’ because they allowed him to act like a real scientist, making decisions about how to collect and analyze data that a real scientist felt was important and valuable. PSTs became more empowered to engage in science that affects their community as a result of working alongside scientists who considered their work meaningful.

In addition to the culminating poster presentation, one aspect of the inquiry project the PSTs considered most essential for their movement into a CoP was the requirement to develop some type of outreach component to make recommendations based on their data (examples of student outreach projects included website designs, podcasts, and brochures). During the development of these projects, it was evident that the PSTs came to care about their issue and realize that they held unique knowledge to which many of their peers did not have access. For example, one student said,

*"We knew so much about our topics- really important topics that not that many people know much about" (Barrey). As Leona also expressed, "our project was very unique because it was created by us from the roots up. There have been no other studies of this nature on our campus...No one has ever tried to set up e-waste recycling bins for regular use at our campus."*

Because PSTs felt they had begun ‘grassroots’ initiatives, they were excited about aims to raise awareness with others and inspire change among their peers on campus. It was clear that they also felt confident in their understanding of their particular environmental issues and felt they had ownership of their inquiry data- indicating their positionality with respect to their science learning, which in effect was that they were inside of a community of practice in which their unique knowledge of science differentiated them from their peers.

For example, the e-waste group in particular developed an inquiry that inspired passion to educate others and create awareness among peers. After researching the effects of leaching of chemicals from electronic waste into the soil, air, and water as well as the global environmental injustices surrounding this issue, students became intent on changing behaviors of college students on our campus. As Bryce had illustrated in his photo (see Figure 1) of e-waste that had been discarded in the dumpster behind his fraternity, his group decided to actually create e-waste stations for computers, batteries, cell phones, etc...at which they would collect and properly dispose of the waste. To do this, they not only needed to research proper disposal and connect with local companies who would be able to support this effort, they also needed to obtain permissions to place collection sites on campus.



Figure 1. Bryce's picture of e-waste in a dumpster behind his fraternity (Classroom artifact)

The PSTs of this group, because of their intent to make a difference on campus, connected with countless community members in addition to their collaborating scientist to raise awareness among their peers and offer an alternative to throwing e-waste into a dump that would end up in the landfill. One member of the group even offered to maintain the e-waste collection site for the entire academic year, extending her responsibility past our semester class:

*“I was responsible to ensure an e-waste bin in their [the dormitory] lobby. I had to promise to keep checking the e-waste bin through the rest of the academic school year” (Leona).*

This dedication led to plans to continue their efforts in the future as they took personal ownership of their projects’ success. This group was an example of PSTs that moved more fully into the CoP by taking ownership of their environmental issue and decided to incorporate into their lives past the course of our semester together.

## Discussion

This section aims to connect the present study back to the literature on the potentials of place-based inquiry to promote ideals of non-scientists’ participation in science in a manner that can inform our theoretical understandings of and practices within elementary teacher preparation. As such, the usefulness of the framework around which the course intervention was centered, the CoP, is examined through a focus on the ability and obstacles of PST participants to enter into a shared community of practice with campus scientists.

### PSTs Inclusion in a Community of Practice with Scientists

Lave and Wenger’s (1991) original conception of legitimate peripheral participation (LPP) as well as reconstructions of the concept furthered by Wenger et al. (1998, 2002, 2007) to extend notions of a community of practice were useful in framing the PSTs’ experience within the presented curriculum. The PSTs became peripheral participants in a community of practicing scientists, moving from external observers of science to active participants alongside scientists researching campus environmental issues. PSTs (the ‘newcomers’) were involved in real, or legitimate, participation as a way of learning—of both absorbing and being absorbed in the ‘culture of practice’ (Lave & Wenger, 1992, p. 95) of practicing scientists. In the presented place-based context, PSTs engaged in an authentic experience of collaborative scientific inquiry and were provided the opportunity to make critical decisions about content and research design in an effort to propose recommendations to the scientific community which were valuable to the ‘old-timers.’ As was seen by Meyer and Carlsen (2001) based on their study of PSTs’ entry into a community of practice, an extended period of legitimate peripherality provided learners with opportunities to make that culture of practice theirs.

Throughout the study, we looked for instances of PSTs experiencing movement into a CoP. Guided by Wenger’s (1998), three elements (i.e. 1) shared repertoire; 2) mutual engagement; and 3) joint enterprise) that are crucial in distinguishing a community of practice from other groups and communities, we came to determine that indeed all PSTs did experience some degree of movement into a CoP with their collaborating scientists. With regard to the *shared repertoire*, PSTs learned about campus environmental issues and how they intersected with the varied interests of students, they developed an expertise that enabled them to understand and contribute to the shared domain of interest in the CoP. As they began to share what they were learning with their peers, they identified as knowledgeable about these topics and as possessing an understanding which differentiated them from their peers. Additionally, the PSTs showcased their burgeoning awareness to their peers, encouraging understanding and behavior changes that could mobilize positive environmental change on campus. For example, the e-waste group’s creation of a website to educate their peers and the energy group’s initiation of a Facebook club

regarding ways to reduce energy consumption were a couple of the ways PSTs elected to stay involved as legitimate participants in the scientific community. Although this was not a requirement of the course, many PSTs chose to do this of their own volition, indicating a shift in their identity as outsiders of science to insider-status. Thus, some PSTs moved closer toward full participation than others and this participation was fluid in terms of its consistency and longevity.

In terms of the *mutual engagement* of a CoP, the PSTs developed relationships of mutual learning and contribution with the scientists in the CoP, and they felt as if they were not only welcomed by the community at Green Drinks and by the scientists, but allowed to contribute data and resources to help advance the scientists' sustainability initiatives on campus. Here, the learners built relationships with scientists that enabled them to learn from each other. PSTs and scientists attended one another's final symposiums and in some cases incorporated each others' work in their suggestions. An exception to this was Clara's group who did not feel as if they were able to contribute to the community garden project goals, but rather were limited in what data (economics of organic foods) they were allowed to collect and analyze. Finally, regarding the *joint enterprise*, PSTs had to conduct inquiries alongside scientists in which they collected and analyzed data from the campus community to contribute to the scientists' campus environmental management plans. In this vein, some of the participating scientists were more involved in data collections and utilizing the data the PSTs collected than others.

The opportunity structures that allowed for PSTs to develop a sense of agency were seen in the willingness of scientists to grant permission for the PSTs to develop novel pursuits within their inquiry topic as well as to allow PSTs to contribute data and educational outreach paraphernalia to aid their research. Despite the scientists' concerns that working with PSTs might interfere and complicate their work as well as the differential for what was at stake (a classroom project for PSTs versus their job for the scientists), the scientists were willing to take on this new partnership because of their perception that it would confer academic relevance to their work and further their cause by involving future educators in environmental concerns. Each student-scientist group not only investigated a different environmental topic, but negotiated the boundaries of their relationship differently. Thus, boundaries were flexible and malleable, enabling the structure of the partnership to be determined by all participants. Utilizing the model of CoP for PST-scientist partnerships rather than that of research apprenticeships allowed for the PSTs to authentically engage in scientific inquiry and take ownership of the direction and usefulness of their project. The recommendation made by Sadler, Burgin, McKinney, and Ponjuan (2009) that learners be engaged in the higher-order practices of research, including analysis of data, generation of hypotheses, and development of research questions was evident here and was a determinant in the level of engagement in the CoP.

### **Developing a Community of Practice through Place-based Inquiry**

Melear (1999) demonstrated that PSTs benefit from opportunities that allow them to hang around with scientists and become properly enculturated into the science they will be expected to teach. Our findings support and extend this research. We came to realize that by designing an experience that centered on place-based inquiry issues, our PSTs also contributed knowledge about their experiences with these issues from a participatory insight. As consumers, they knew what foods were available to them and were able to assess the accessibility of wholesome nutrition. As residents, they understood what conservation practices were or were not in place in their dormitories. Some of them were participants in the Office of Sustainability's energy challenge and had information about the effectiveness of awareness campaigns. Thus, PSTs were able to contribute insights into campus practice to which the scientists did not often have access. Due to the place-based nature of the inquiry, PSTs felt as if they had something to offer to the conversation.

Additionally, the inquiry being centered in the PSTs' place allowed for connection to local community members in addition to the scientists. Assessing the PSTs' movement through varying levels of LPP was gauged by the various conversations in which they took part with not

only the scientist partners, but also in their dialogue with community members as well as their peers. PSTs extended their participation beyond the classroom and student-scientist partnership through experiences such as showcasing their photography at Green Drinks. Talking to community members who shared an interest in their topic encouraged PSTs think more deeply about their inquiry investigations and broadened their perspectives, which gave them insights into their project design. They felt welcomed to share ideas and that their ideas were valued. In this experience, the tight integration in the collaboration allowed for PSTs to contribute meaningful data to the scientists which was enabled through their developing research questions and data collection protocol alongside the scientists. Having the scientists actually attend class early on in the semester was helpful in enhancing their burgeoning partnership. Through their discussions, PSTs came to realize what information they needed to understand to take part in community conversations about the environmental issues and increase their peers' awareness of these issues.

### **PSTs' Identity Formation**

Several of the PSTs claimed they "*felt like scientists*" as they progressed from the periphery to a more full expression of participation in scientific inquiry. Many of them claimed that their prior experiences with science centered on confirmatory laboratory experiments, and the opportunity to participate and contribute to authentic projects that were personally relevant to them was a novel experience. Situated cognition theorists have argued that engaging students in authentic situations will help them achieve understanding, but these situations should extend beyond a real world context to include other social participants in the learner's experience (Heeter, 2005). In terms of the extension to collaboration, most PSTs came to feel included in and a part of the dynamic process of science with regard to campus environmental initiatives, expressing their enthusiasm about "*making a difference*" and "*being valued by the scientific community.*" Their shared dialogue with the scientists along with their ability to contribute unique data and create educational outreach materials enabled PSTs to begin to perceive themselves as integral participants in a pursuit to improve environmental concerns on campus.

Although all PSTs were able to participate in dialogic relationships with the scientists, it was clear that there were understandable boundaries that prevented full participation in the community of practice. It was not desirable for complete movement of PSTs to full participation. The learners were not trained formally in science and despite their learning scientific inquiry contextualized within participation with scientists, they maintained their identity as PSTs, not budding scientists. Movement toward full participation in this study did not mean propelling learners into higher or fuller stages when neither earned nor desired. It was precisely this positioning that made the PSTs' contribution to the science meaningful. Thus, the scientists appreciated the student viewpoint because it added a layer to their data and potential effectiveness of proposed solutions to some of the campus environmental issues. In this vein, the goal of the CoP was not an apprenticeship model of students training to be scientists, but rather to operate within the community as peripheral participants. While this experience met the goals of a CoP, its intention was never for PSTs to gain complete full participation. Thus, the ability for students to be agents in the student-scientist collaboration was influenced by not only their own motivation to be involved, but also by the inherent structures embedded in the experience itself. A few of the PSTs felt their collaboration to be stifling in terms of having to obtain proper permissions to do the projects they wished to do and having to negotiate their research questions with the scientists who may have had something else in mind.

Based on our data, the PSTs benefited in their development as future science teachers by participating, albeit peripherally, in a CoP. The contextual and experiential learning opportunities in this experience not only increased their understanding of scientific issues in their own community, but enabled them to have bring forth their own perspectives and understandings to the issues at large. PSTs were able to experience the culture of science first-hand. In conclusion, PSTs were able to participate in a CoP engaged in authentic scientific inquiry and were able to move through levels of LPP in varying degrees while maintaining their status as PSTs. It was not



the goal of the curriculum to transition PSTs into scientists; it was a goal of the curriculum that they collaborate to contribute unique knowledge sets to propose solutions about campus environmental concerns.

### **Implications and Recommendations for Elementary Teacher Education**

The NRC (2000) book, *Inquiry and the National Science Education Standards*, stated the importance of “the need for teachers to do inquiry to learn its meaning, its value, and how to use it to help students learn” (p. 91) and of developing a community of teacher-learners who “mirror the scientific communities” in which teachers have been immersed. It is important that our PSTs have opportunities to connect with the community of science surrounding them. We have come to realize that the multi-faceted collaborative aspect of this approach including dialoguing with community, collaborating with scientists, and raising the awareness of peers was paramount in enhancing our students’ experience of participation in a CoP.

In our study, PSTs identified the concerns and then went on to design the study, collect the data, analyze and interpret the results, and then turn the data into action. We found that in this participatory process, the PSTs worked alongside scientists seeking solutions to campus environmental issues, allowing bonds of trust and mutual respect to develop. An aim of this project was to shift the power and control of decision-making into the hands of learners and to build their capacity to gather and contribute knowledge for action in a democratic and participatory manner. In our study, the PSTs did not take on the roles of professional scientists. They did, however, begin to take on the roles of knowledgeable and concerned teachers. As we watched, they defined their own roles—role definitions that we will now take forward into our future efforts associated with this project. Specifically, we will question the ways in which we could/should foster this role identity over the course of the semester; seeking to understand how such interactions affect their teacher identity and the implications for their future classroom practice. Furthermore, PSTs experienced scientific inquiry they had not yet had the opportunity to experience in their learning of science thus far. As future teachers, they were able to realize that this type of teaching is an important part of the classroom. For future study, we would like to follow up with the PSTs to investigate the ways in which they are able or eager to re-create a similar type of learning experience for their own students.

We also learned how to structure collaborations to maximize potential benefit to all participants. Teacher educators should aim for student-scientist partnerships that relate to issues with a variety of perspectives and necessary participants (i.e. like the environmental issues explored here). Incorporating participation in informal campus community events like Green Drinks is also an important part of students’ entry into a CoP. Students’ bringing their ideas that they’ve developed in class to the monthly event gave them something to dialogue about without placing too much pressure on them. It was essential the students knew basic ecological concepts about their issue and had done some initial research into what the status of the issue in the community was and why work was needed on it. Finally, because the success of these partnerships depends just as much on the scientists, it is paramount that clear expectations are outlined prior to working collaboratively. For this reason, having the scientists come to class to meet with students and plan the projects worked well. In the future, we will also have students talk to the scientist about what both parties hope to get out of the partnership to avoid the pitfalls we saw in some of the projects.

The main scholarly implication of our study lies in the impact of the role identities in regards to theoretical discussions of internship programs for science teachers. Our approach made some progress in promoting PSTs’ involvement in the scientific community of practice. Nonetheless, despite our efforts, most PSTs did not achieve full participation in the scientific community. Our first reaction was to look upon this experience as flawed in this aspect. Looking at the experience through the eyes of our PSTs, however, we have come to view such CoPs in a new light. We have come to understand that the goal should not be to get our teachers to become full participants in the scientists’ CoP; but to develop a new CoP that involves scientists, teachers

and community members. In this reconception of a new CoP—one that includes teachers as peripheral participants—students have access to the scientific community. If pre-service teachers who engage in partnerships with scientists on campus maintain participation in these or other scientifically-oriented CoPs, they can enable their students to participate in and contribute to the efforts of scientists in their community.

We have come to realize that the structuring of this student-scientist experience more closely aligned with many aspects of ‘Citizen Science’ (Cohn, 2008) programs offered in both formal and informal science education experiences than with the theoretical approach traditionally serving to underpin discussions of teacher internship experiences in scientists’ labs. Wilderman, Barron, and Imgrund (2004) operationalize citizen science collaborations on a continuum of more directed by scientists (a “top-down” approach) to be driven by learner interest and engagement (a “bottom-up” approach). Researchers showed that bottom-up approaches to citizen science collaborations increase student 1) interest and engagement in the project, 2) ownership and understanding of the data, 3) building of community capacity, and 4) empowerment to act. The difference is that this approach allows for a CoP in which PSTs are allowed to be future teachers; not future scientists. Using Wilderman et al.’s guide to the categorization of citizen science, Table 1 shows the PSTs’ collaboration with scientists to be characteristic of a bottom-up approach:

Table 1. Categorizing student-scientist collaboration using Wilderman et al.’s schema (2004)

Who defines the prob-	Who designs the study?	Who collects the samples?	Who analyzes the samples?	Who inter- prets
Student	Student a- longside scientists	Student	Student	Student

During the semester, the PSTs were engaged in a relationship with scientists who shared their concerns about their campus. The students, as active members of this campus community and future educators, sensed they were a valuable part of the community. Their ability to succeed in this community was strengthened by the observation of other members who were interested in their contributions as PSTs. When they do enter the classroom; however, they will both take and be given different roles. Further research is needed to learn whether the lessons learned in our course could translate to a new CoP in which teachers and scientists are both learners and experts.

In addition, we wonder if their school environment will value the time and effort associated with establishing such a CoP. We believe that the question of facilitating this change will come down to a personal sense of capacity to balance multiple roles. Further studies are needed to explore possible conflict and difference in the merging of different cultures to form a new scientific community. In conclusion, from the data we realized that place-based inquiry, as well as the privileging of our students’ voices in the community by way of student-scientist partnership was foundational for deepening their understanding and connection to science as a process. This also underscored the authentic movement of PSTs into a fuller (and more empowered) expression of democratic participation in a scientific community shaped by inherent, yet malleable, boundaries. As such, the importance of this study lies not only in the critical transformation of our own theoretical understandings and practices associated with our science course for PSTs, but in the extension of place-based inquiry curriculum serving as a context for empowerment and engagement of PSTs in science as well.

## References

- Akerson, V., Donnelly, L., Riggs, M., & Eastwood, J. (2012). Developing a community of practice to support preservice elementary teachers' nature of science instruction. *International Journal of Science Education*, 34, 1371-1392.
- Akerson, V., Cullen, T., & Hanson, D. (2009). Fostering a community of practice through professional development program to improve elementary teachers' of nature of science and teaching practice. *Journal of Research in Science Teaching*, 46, 1090-1113.
- Battistoni, R. (2002). *Civic engagement across the curriculum*. Providence, RI: Campus Compact.
- Carspecken, P. (1996) *Critical Ethnography in Educational Research; A Theoretical and Practical Guide*. New York and London: Routledge.
- Cohn, J. (2008) Citizen science: Can volunteers do real research? *BioScience*, 58, 192-197.
- Dos Santos, W. (2008). Scientific literacy: A Freirean perspective as a radical view of humanistic science education, *Science Education*, 93, 361-382.
- Freire, P. (1970). *Pedagogy of the oppressed*. New York: Continuum.
- Habermas, J. (1984). *The theory of communicative action volume one: Reason and the rationalization of society*. Boston: Beacon Press.
- Heeter, C. (2005). Situated Learning for designers: Social, Cognitive and Situative Fra work. Retrieved on February 26, 2008 from the Michigan State University Web site: [http://teachvu.vu.msu.edu/public/designers/social\\_interactions/index.php?page\\_num=4](http://teachvu.vu.msu.edu/public/designers/social_interactions/index.php?page_num=4)
- Hodson, D. (2003). Time for action: Science education for an alternative future. *International Journal of Science Education*, 25, 645-670.
- Hughes, G. (2000). Marginalization of socioscientific material in science-technology-society curricula: Some implications for gender inclusivity and curriculum reform. *Journal of Research in Science Teaching*, 37, 426-440.
- Kemmis, S., & McTaggart, R. (2000). Participatory action research. In N. Denzin & Y. Lincoln (Eds.), *Handbook of qualitative research* (pp. 567-605). Thousand Oaks, CA: Sage.
- Kolstø, S. D. (2001). Scientific literacy for citizenship: tools for dealing with the science dimension of controversial socioscientific issues. *Science Education*, 85, 291-310.
- Kolstø, S. D., Bungum, B., Arnesen, E., Isnes, A., Kristensen, T., & Mathiassen, K. (2006). Science students' critical examination of scientific information related to socio-scientific issues. *Science Education*, 90, 632-655.
- Lave, J. & Wenger, E. (1991). *Situated learning. Legitimate peripheral participation*. New York: University of Cambridge Press.
- Melear, C. (1999). Middle and secondary science teacher opinions about working in scientists laboratories during preservice preparation. *Electronic Journal of Science Education*, 4, (2).
- Merriam, S. (1998). *Qualitative research and case study applications in education*. San Francisco: Jossey-Bass Publishers.
- Meyer, D., & Carlsen, W. (2001). Curriculum design and legitimate peripheral participation by preservice teachers. Paper presented at the annual meeting of the National Association for Research in Science Teaching, St. Louis, MO, March 25-28.
- National Academy of Sciences (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: The National Academy Press.
- NGSS Lead States. (2013). *Next Generation Science Standards: For states, by states*. Washington, DC: National Academies Press.
- Pelo, A. (2009). A pedagogy for ecology. *Rethinking Schools*, 23, 30-35.
- Roth, W., & Lee, S. (2004). Science education as/for participation in the community. *Science Education*, 88, 263-291.
- Sadler, T., Barab, S., & Scott, B. (2007). What do students gain by engaging in socioscientific inquiry? *Research in Science Education*, 37, 371-391.

- Sadler, T. D., Burgin, S., McKinney, L., & Ponjuan, L. (2009). Learning science through research apprenticeships: a critical review of the literature. *Journal of Research in Science Teaching*, 47, 235-256.
- Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. New York, NY: Cambridge University Press.
- Wilderman, C., Barron, A., & Imgrund, L. (2004). Top down or bottom up? ALLARMS experience with two operational models for community science. In Proceedings of the 2004 National Monitoring Conference, Chattanooga, TN, May 17-20. National Water Quality Monitoring Council.

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**Appendix B: Description of Place-based Inquiry Projects & Partnering Scientists**

Inquiry Topic	Inquiry Question	Project Description	Science Content Embedded in Project	Background of Partnering Scientists
Electronic Waste	If provided with easy-to-access options for disposal, would students recycle their e-waste?	Group placed e-waste collection bins and educational flyers inside three residence halls to gauge amount of that could be recycled; conducted surveys to assess student awareness of and willingness to dispose of e-waste properly; their e-waste collection sites were adopted for use by the university	-Environmental Science, waste effects -Measuring, data collection, interpreting lab results -Chemistry, elements, compounds -Health, toxic hazards	Master of Public Affairs and a Master of Science in Environmental Science with concentrations in Sustainable Development and Applied Ecology
Nutrition	Does nutrition awareness affect food choice among students?	Group conducted a pre and post analysis of 'healthy' vs. 'non-healthy' choices made by students after being made aware of nutritional facts; results helped develop a blog for motivating students to participate in a healthy eating campaign	-Research-based guidelines for a nutritionally balanced diet -Relationship between poor eating habits and chronic diseases -Food processing effect on food quality, safety, nutrient content, and the environment	Registered Dietitian with RPS Dining Services; B.A. in Dietetics M.A. in Community Nutrition
Energy	What motivates students and faculty to become more energy conscious and be actively involved in energy conservation?	Group surveyed students, professors, teachers assistants, and building managers from both the Chemistry building and a Dormitory in order to determine a plan of action for incentivizing energy conservation	-Energy types, sources, conversions, and their relationship to heat and temperature -Advantages and disadvantages to alternate forms of energy -Inquiry process skills	Master of Public Affairs and a Master of Science in Environmental Science with concentrations in environmental policy and natural resource management and applied ecology
Community	Would the availa-	Group collected	-Soil properties	Master of Science

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Gardens	bility and variety of produce affect the demand for produce on campus?	data on prices of Locally grown/organic produce and store-bought non-organic produce and conducted a survey investigating students' purchasing choices to provide data for planning and participation in community gardening	and growth -Human impact on the environment -Organic vs. non-organic impact on food systems	in Environmental Science with concentrations sustainable development and applied ecology; B.S. in biology and a B.S. in anthropology
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